State of Nevada
Department of Information Technology
Computing Facility

Mainframe Sysplex
Today, Tomorrow and Beyond
June 2002

Contents

Executive Summary

State of Nevada agencies rely on the Computing Facility to provide data processing support in a secure 24x7 environment. Platforms managed include two mainframes. Mainframe utilization continues to increase. Within the next fifteen months capacity needs are expected to exceed current availability.

This forecast resulted in considering alternatives to continue to meet the State's requirements. This presentation explores three alternatives:

1. Replace the existing hardware with current technology hardware that will provide the necessary capacity, scalability, and longevity expected with an enterprise server replacement.
2. Upgrade the existing architecture that provides a "short-term" solution that meets the necessary capacity through the near term.
3. Retain the existing hardware and manage the system resources through accepting less performance.

After comparing the cost and benefits of each alternative, we determined that the best solution is a complete hardware replacement with the most current architecture.

Existing hardware (both the R-35 and the R-46 and coupling facilities) would be replaced with an IBM z900 series enterprise server with an Internal Coupling Facility. The proposed upgrade represents an approximate 36% increase in MIPS[1] capacity. This replacement will satisfy the growth requirement through the next biennium based on customer projections and time trend analysis. It also provides a stable and scalable platform for future capacity requirements. If capacity or performance needs increase or decrease, this platform can be adjusted accordingly. We would then be billed at the new MIPS level.

The mainframe hardware procurement will cost an estimated $2,124,400.00. Additional software licensing fees will account for approximately $1,888,250.00 annually. Maintenance contract expenditures will increase by approximately $10,171.00 monthly. Other costs anticipated in association will be increased storage costs and business continuity resources which will be proposed as part of the budget, since they will be required regardless of the mainframe platform.

The recommended replacement will also provide several strong benefits. In addition to the increased capacity, we will be able to maintain both hardware and software support as well as have significant scalability in the event that additional capacity is necessary. Through the use of workload manager, the management of the available resources is more precise.

Our upgrade path continues to be with IBM, Inc. due to several factors. Other vendors were considered. Due to reliability, as documented in studies of mainframe computing systems between different manufacturers, IBM continues to be the most viable selection. Consideration of costs to migrate to another platform such as UNISYS or HP, also support the decision to remain with the same operating system. At a minimum, major portions of interface code would need to be rewritten, possibly entire applications.

This replacement provides adequate transaction throughput and response time based on growth projections. If an upgrade is postponed through the biennium, the state will likely experience capacity saturation in October 2003. This saturation will result in *extreme* degradation of performance across all applications on the saturated computer. For example, extreme degrading would be 45 minutes just to log on to the application. Mainframe resources can only tolerate 90% utilization during peak period and perform optimally below 80% utilization. As utilization increases, overall performance deteriorates exponentially.

[1] Millions of Instruction per Second: A relative measurement of CPU processing power. Current capacity is 612 MIPS, upgraded system provides an addition 223 MIPS.

Current Hardware and Capacity

The State of Nevada provides centralized enterprise server resources for use by individual agencies throughout the state. Many agencies use these resources to host their applications and corresponding databases. The current environment is comprised of two large computing systems coupled together[2] to provide necessary and secure data processing facilities.

R46 and R35 High Level

The larger of the two computers is an IBM 9672-R46[3], a fifth generation, four processor machine. It provides the bulk of the computer resources available for computing needs. The R46 provides approximately 447 MIPS[4] of available capacity. Our primary consumer of resources is the Nomads[5] application, which resides on the R46.

The second computer is an IBM 9672-R34[6], a fourth generation, three processor machine. The R35 provides approximately 165 MIPS of additional capacity. The two primary consumers of resources on the R35 are the Department of Motor Vehicles and Department of Employment, Training and Rehabilitation.

The combined resources total seven processors at 612 MIPS. However, due to the different generations of the two machines, total resource sharing is not feasible.

Sysplex

The two computers are linked together with a coupling facility to provide the benefits of a Sysplex. The common benefits of the Sysplex include reduced software licensing fees, more efficient administration of both machines, and the possibility of sharing resources. For example, RACF, the security administration of the mainframe is part of the Sysplex.

Sysplex Capital Investment to Date

Many questions regarding the on-going investment into the current sysplexed environment have come up. Though the historical investments in the SYSPLEX have been substantial, they have all been a result of increasing capacity requirements and desires to reduce long term expenses rather than directly related to creating and supporting the Sysplex itself.

Expense and Justification

Between July 1998 and September 2000 expenditures related to the Sysplex environment were approximately $8.4 million. The expenditures accounted for mainframe capacity upgrades that simultaneously benefited the ability to Sysplex the two mainframes together. During this time, there was significant growth in CPU utilization due to the quickly growing requirements of the individual state agencies.

Research

Responses from other states about their mainframe environments and their typical expenditures were consistent with our expenditure and upgrade history. Three questions[7] were submitted to the states for response. The State of Colorado has seen historical upgrades approximately every eighteen months, with complete hardware replacements every five years. The State of Montana reports that they upgrade processor, storage and disk capacity on an annual basis and that their annual investment has averaged

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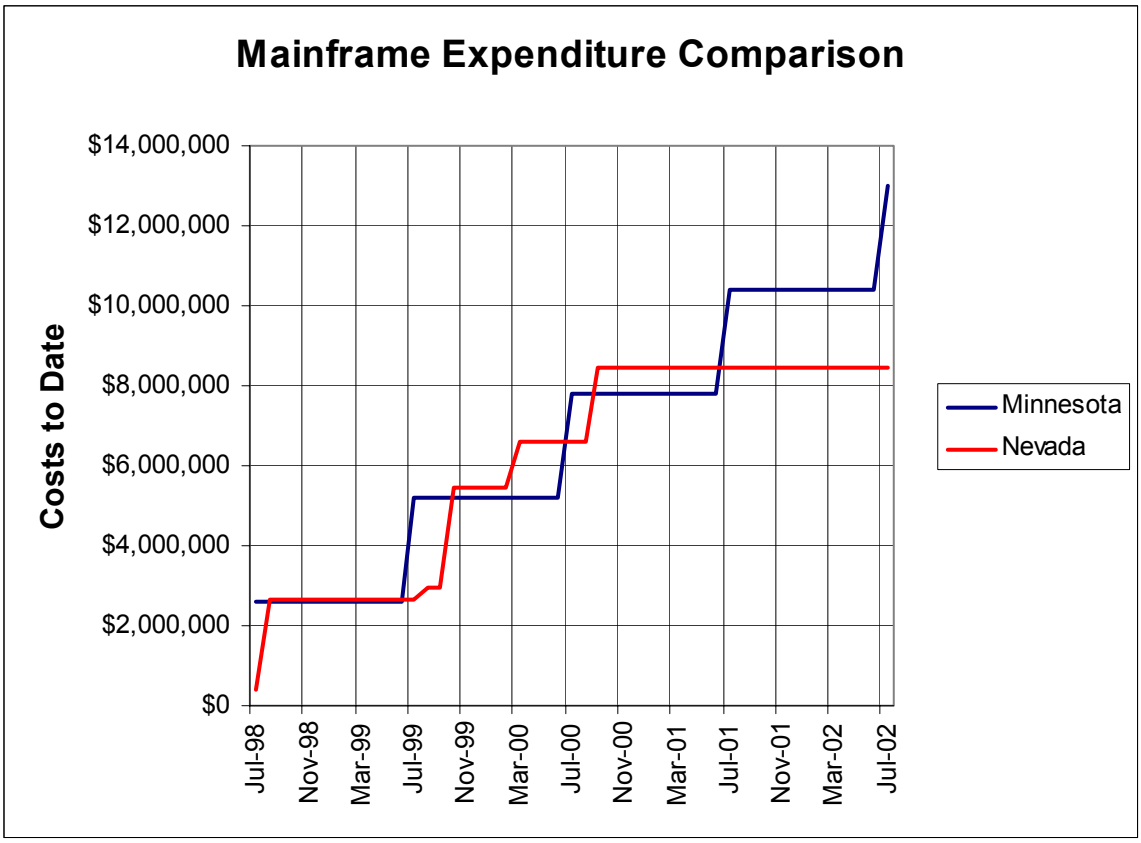
[2] Coupled mainframes commonly termed “Sysplexes.”
[3] Also known as the “R46” or “P1.”
[4] MIPS: Millions of Instructions per Second, a general method of measuring and comparing capacity of enterprise servers (mainframes).
[5] NOMADS: Nevada Operations of Multi-Automated Data System.
[6] Also known as the “R35” or “P2.”

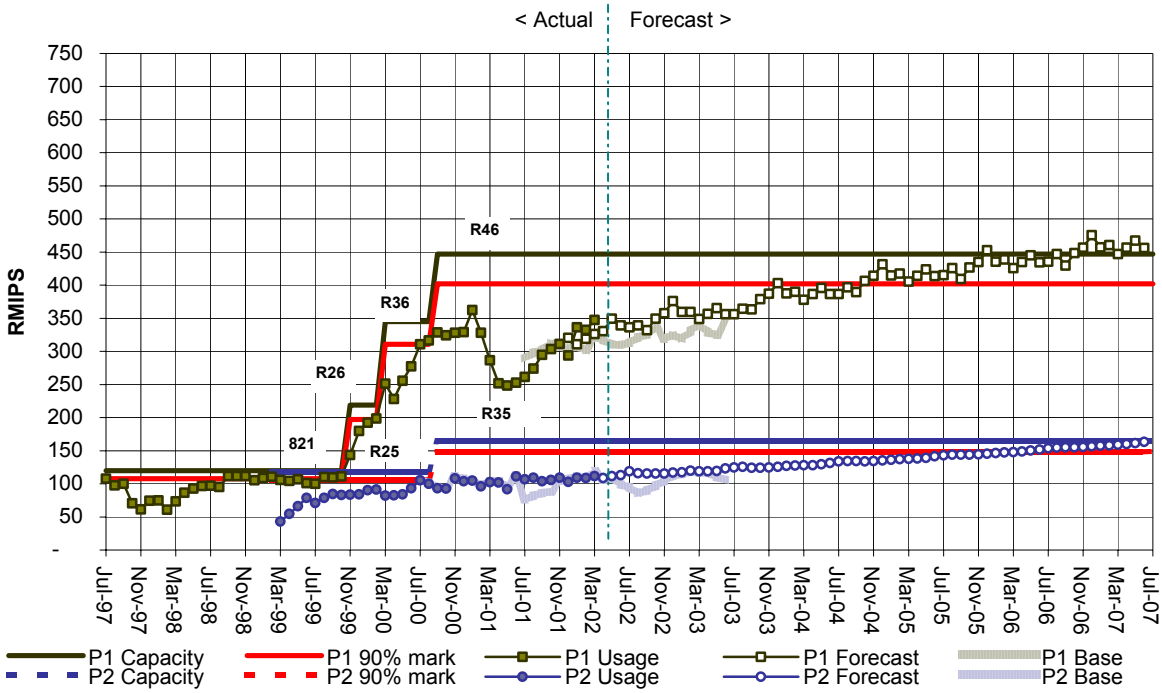
$2,600,000.00 USD annually since 1996. (Source: Emerging Technology, DoIT). For comparison, the State of Nevada has spent $2,100,000.00 USD annually since 1998, and we have upgraded our existing hardware four times in the last four years, though all upgrades occurred prior to October 2000.



Capacity and Utilization Projections

The State of Nevada Capacity Plan is published quarterly and provides updated information about agency projects and utilization forecasts. The plan also contains a two-year forecast for overall resource consumption. Seasonality and time trend analysis are the primary methodologies used to calculate the two-year projections.

The following is the official capacity utilization forecast for the Sysplex. It shows that based on current and historical growth patterns, we will exceed our system capacity for the R46 in December 2003. This is the primary justification for an upgrade.



Driving Factors

The driving factors for the projected growth are generally related to increased application utilization. Welfare's NOMADS application consumes 70% to 75% of total resources consumed. Subsequently application enhancements, Federal and State changes to existing requirements and increased application utilization directly affect statewide capacity needs.

An unknown factor at this time is bifurcation process for the DCFS application UNITY. In order to consolidate the Clark County system with UNITY, there will be changes to the application that will affect capacity needs, as well as the enlargement of the database and increase in customers. The design of the application modifications, the size of the database growth and the increase in the number of users could result in capacity needs well above the forecast.

Efforts to synchronize data to open systems platforms for reporting needs has also affected resource requirements. Additional exploitations of this technology will have an unknown effect on overall consumption.

Assumptions and Risks of Projections

Projecting future capacity requirements is a delicate matter. There are a number of assumptions and risks that are associated with these projections.

Customer Input

Though we use seasonality and time trend analysis for the overall projection, customer input and projections based on their project timelines are also incorporated. This places significant reliance on the customers' ability to predict business changes within each agency. Obvious issues would include un-planned changes in socio-economic conditions and legislative changes with regard to agency requirements.

Shortcomings of Current Projections

Currently, though we have forecasts for the individual agency resource utilizations, we do not use those forecasts to determine the overall utilization forecasts. We must then rely upon manual manipulation of the forecast to incorporate agency forecasts. This allows for significant human error and allows the process to be excessively subjective regardless of historical accuracy. Lack of dedicated staff to manage the capacity planning process has historically been the key-contributing factor to the lack of refinement in the process.

Process Improvement Underway

The capacity planning process is being enhanced and a greater reliance on existing tools will provide the foundation for a more automated and straightforward overall capacity planning effort. This will provide improved justification for our utilization projections. Overall accuracy of the capacity planning process should benefit from the process changes as well.

Hardware Upgrade Solutions Overview

After reviewing the utilization projections for the next biennium, it became clear that an upgrade would be necessary to satisfy the needs of the state's agencies. We investigated two potential changes to the environment to accommodate the increased capacity requirements.

- The first alternative is to replace the existing hardware with current technology hardware that will provide the necessary capacity, scalability, and longevity expected with an enterprise server replacement.
- The second alternative is to upgrade the existing architecture that provides a "short-term" solution that meets the necessary capacity through the near term.
- The third alternative is to retain the existing hardware and manage the system resources through accepting less performance.

Though the upgrade alternative will be less expensive than the replacement in the short term, our recommendation is proceed with the replacement in order to mitigate other contributing factors as well as to minimize expenditures over the long term.

Replacement of Current Architecture with Z-Series 900

The Z900 replacement represents a complete environment migration. The resulting environment would address the key concerns of capacity, scalability and longevity. We expect that this platform could

sustain us for the next four to five years, with upgrades necessary along the way, but no replacement slated until the end of that term. The R46, R35 and external coupling facility (providing the Sysplex functionality) would all be migrated to one machine, and in the process would retain all the current available functionality. Centralization of processing on a single footprint would minimize internal administration costs associated with managing the different platforms. This generation of architecture and the proposed capacity would allow us to segregate certain large applications so that we could also improve overall system availability by minimizing downtime to the entire system when upgrades for individual partitions was necessary. The strongest argument for the single footprint is the ability to constantly utilize all of the resources in the machine. Our current architecture, as in the open systems environment, places "headroom" for peak utilization on more than one resource that creates an excess of unused capacity. Combining the system into one footprint will allow us to manage application access to excess capacity, thus improving overall performance and simultaneously lessening the need for large areas of underutilized resources to account for potential peaks.

Architecture Overview

The architecture would consist of one IBM Z900 104 Enterprise Server with and Internal Coupling Facility[8]. This provides four current generation processors. An additional processor would be enabled for use as an Internal Coupling Facility. The ability to co-locate all of our processing on this new technology would significantly simplify our architecture. A net gain of 223 MIPS would be realized.

Cost Analysis

Quotes received from IBM approximate the cost of replacing our current architecture with a Z900 series at approximately $2,124,400.00 for hardware. The estimated costs represent a complete replacement of existing hardware with new components. A monthly support cost $21,400.00 would be incurred to support the hardware. This represents a net increase of approximately $10,171.00 monthly. The largest expense will come with software licensing changes due to increase system capacity. We expect an annual increase of $1,888,250.00 in costs associated with software licensing.

Support Horizon

Upgrading to the Z900 series architecture protects us from software incompatibility issues due to operating system requirements that are approaching. The primary difference in architectures is in memory addressing. The Z900 utilizes a 64-bit memory-addressing scheme while the existing architecture is only capable of 31-bit processing.

Future Upgrades

Future upgrades will be incremental in nature. Addition of CPU resources is dynamic, requiring no interruption of services. Certain types of storage (memory) increases are also available on demand. Capacity on demand by nature will increase system availability and minimize the need to extended service interruptions due to upgrades.

Upgrade of Current 9672-R35

Architecture Overview

The existing architecture would remain in place. The fundamental change would be to upgrade R35 (P2) to an IBM 9672-R36. This would retain the same number of processors, but would upgrade them to the same generation as in the R46 (P1). A net gain of 180 MIPS would be realized and would provide the capacity necessary through the next biennium.

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[8] The Internal Coupling Facility (ICF) will be used to create the Sysplex as it existed on the previous platform.

Cost Analysis

The hardware upgrade will cost an approximate $511,000.00, significantly less than the Z900 upgrade. The annual increase in software licensing charges, however, would only be nominally less than the Z900 proposal, at $1,524,060.00.

Support Horizon

As mentioned previously, memory addressing is the key differentiation between the architectures. The current system utilizes 31-bit memory addressing while the Z900 series uses a 64-bit scheme. IBM has already announced that several key products, including DB2[9] Version 8 will not be supported on 31-bit architecture, limiting our software upgrade path should we remain on our current platform.

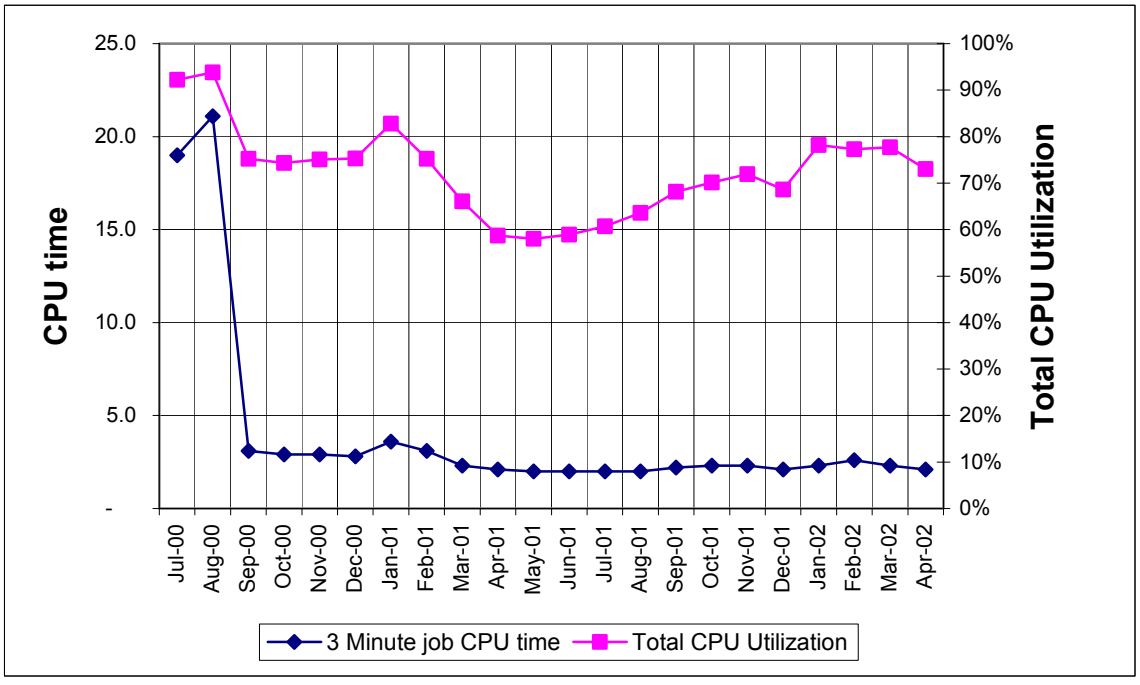
Future Upgrades

As with the existing architecture, upgrades of both processors and memory require system interruption, resulting in decreased system availability.

Business As Usual

Risk Analysis

Remaining on this architecture will have potentially catastrophic effects on the agency's processing requirements. The impact of running a system at 90% of capacity has a significant effect on all aspects of system performance. The standard 3-minute batch job has been a key performance indicator for the Computing Facility and has been measured for a number of years. The job is intended to run in three minutes based on the cycle requirements of the program. The job typically runs in less than three minutes and represents a system performing well. The following chart shows the relationship between the batch job and peak utilization. As the NOMADS application increased its demand, the standard batch job took significantly longer to run. This is a small example of what will occur if the system utilization increases beyond the 90th percentile.

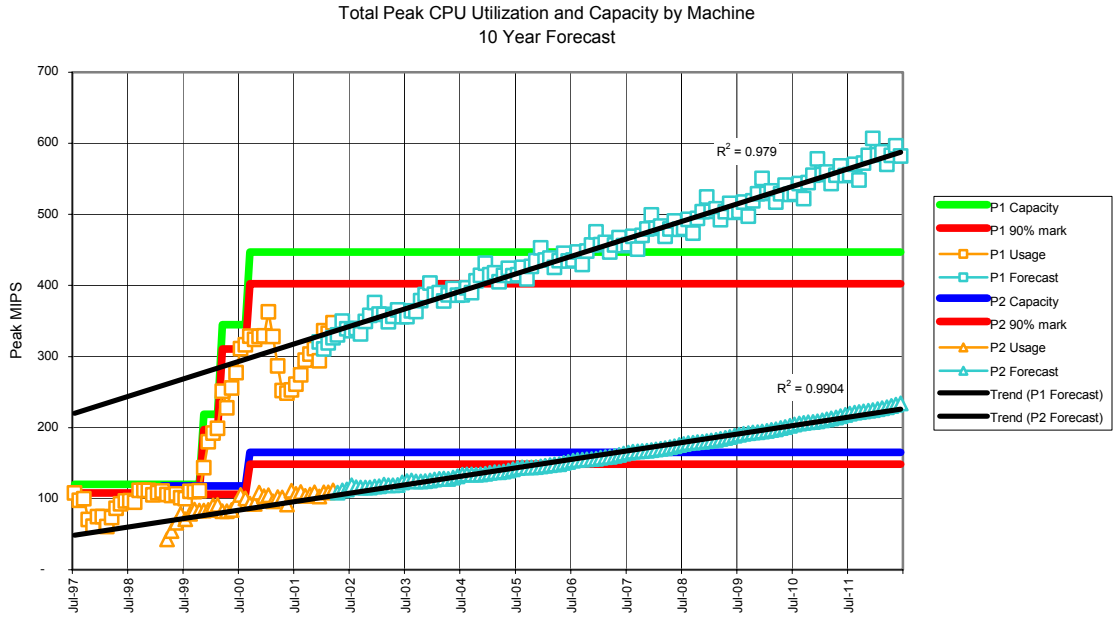


[9] DB2 is a platform that provides the majority of database services on our mainframe.

Future of the Mainframe

Ten Year Forecast

In the Information Technology sector, the reliability of a ten-year utilization forecast is unknown. Historical growth patterns corrected for non-standard growth patterns have been adapted to project the ten-year utilization. The accuracy of the forecast is highly dependent on many independent and unpredictable factors such as socio-economic conditions, agency application development or migration and legislative requirements for agency programs. The attached chart depicts a best guess approach to a ten-year forecast.



How Do We Decide to Upgrade?

There are three key contributors to the upgrade decision process. These contributors are outlined below and are the basic components of the decision matrix provided.

Capacity Concerns

Capacity concerns are the key motivation for upgrades. As a system approaches saturation, exponential effects on system performance occur. Capacity concerns are usually satisfied with upgrades rather than replacements, until such a time where additional capacity is not available on given architecture or the factors listed below dictate otherwise.

Hardware/Software Support

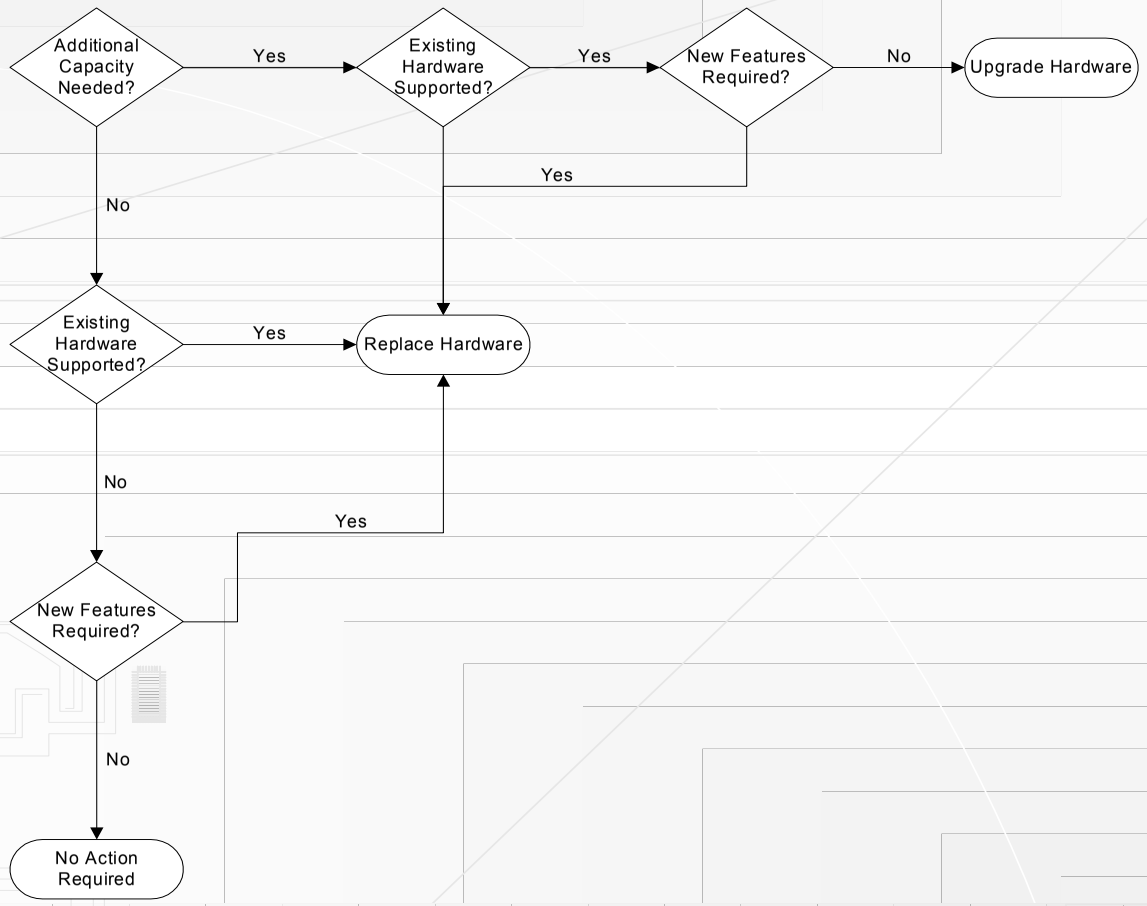
A secondary, yet significant factor is the support of the hardware and software. IBM and other vendors release new versions of software on regular cycles. They offer support windows for software that typically allow you to be three revisions behind on any given product and still be within the support window. Though this window varies from product to product and vendor to vendor, release cycles are often eighteen months in length. This drives the ongoing requirement to upgrade software. Approximately every five years, a hardware replacement is necessary to support required software upgrades. Hardware and software support requirements typically drive a replacement strategy rather than an upgrade strategy.

Additional Features and Technology

Another secondary factor is the opportunity to utilize features and enhancements provided by architectures. This is not usually the initial factor that drives an upgrade or replacement but is often used as a supplement to the above factors. Key elements provided by a new architecture may help justify a replacement of existing architecture.

State of Nevada DoIT
Mainframe Upgrade Decision Matrix

Tuesday, June 04, 2002



Frequently Asked Questions

Why does the mainframe (enterprise server) need to upgrades so regularly?

Enterprise servers are not always subject to upgrade at regular intervals. The primary factors that contribute to the State's upgrade requirements are quickly growing computing requirements at the State Agency level. The NOMADS application alone has been responsible for driving a vast majority of the upgrades in the recent past due to the rapidly growing use and addition of application functionality. We expect the growth trend to continue, and as such expect to continue to upgrade the computing resources. For details regarding each agency's growth projections, refer to the most recent Capacity Plan[10].

What amount should the governing authorities expect to spend annually on on-going operation and upgrades of the enterprise server?

It is expected that the State of Nevada will continue to need additional mainframe resources as well as systems relocated to and developed on other platforms. As a result, the state should plan to continue the on-going investment in the platform. Projected costs are consistent with historical spending trends.

Why can't we move all of our applications to open systems?

Open systems are quickly gaining on enterprise servers with respect to availability and reliability. These have traditionally been the standard by which mainframes have been marketed. Additionally, the application set available on open systems is growing rapidly. Administration continues to be the biggest drawback in the open systems arena. As open systems become increasingly viable as a production environment, the biggest hurdle the state will encounter is that of conversion costs. Large, complex applications are often the result thousands of hours of coding and testing. The amount of effort required to convert these applications to the open systems platform is cost-prohibitive and is the fundamental deterrent from migration. The mainframe remains a more secure environment than open systems.

Are open systems really less expensive to operate and administer?

Gartner Group continues to report the centralized enterprise servers (mainframes) are the lowest cost, highest performers of the computer hardware sector. Significant savings are realized due to high levels of reliability, lower costs associated with mainframe maintenance and administration, and decidedly lower total cost of ownership.

Why do we continue to use IBM as the vendor for our enterprise servers?

We did explore the option of converting to a different "mainframe" such as UNISYS, SUN or HP. Conversion costs are a key factor in platform selection as described in answer #4 above. Subtle, yet significant changes also exist between operating systems of enterprise servers. Though conversion costs may be a factor, the most significant factor is that of reliability. IBM has consistently provided the most reliable platform available for enterprise computing. This is supported by research provided by Gartner Research Group.